A Modified Boltzmann Machine for Solving Distribution System Expansion Planning in Malaysia

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ABSTRACT

This paper proposes an effective technique to solve Distribution System Expansion Planning (DSEP) problem by using the artificial neural network. The proposed technique will be formulated by using mean-variance analysis (MVA) approach in the form of mixed-integer quadratic programming problem. It consists of two layers neural network which combine Hopfield network and Boltzmann machine (BM) in upper and lower layer respectively named as Modified BM. The originality of the proposed technique is it will delete the unit of the second layer, which is not selected in the first layer in its execution. Then, the second layer is restructured using the selected units. Due to this feature, the proposed technique will improve time consuming and accuracy of solution. Referring to the case study demonstrated in this paper, the significance outputs obtained are the improvement in computational time and accuracy of solution provided. As the solution provided various of options, the proposed technique will help decision makers in solving DSEP problem. As a result, the performance of strategic investment planning in DSEP certainly enhanced.

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1. INTRODUCTION

Planning of distribution system has been a very hot topic in the 21st century [1]. Distribution System Expansion Planning (DSEP) is dealing with the continuous increasing load demand. In DSEP, the stages of the plan and overall time span; the methods of treating distribution feeders and substations in terms of cost representation, location and sizing problems; radiality and voltage drop considerations; and the mathematical programming techniques used to solve this problem [2]. It uses a fundamental economic criterion, the 'cost-benefit analysis', in a heuristic selection process of plan options, starting from the terminal year and propagating backward to the initial year, to arrive at a plan solution [3].

On the other hand, the demand for electricity has grown due to the rapid economic development and gradual increase in the world's population [4]. According to Malaysia Statistic Energy Handbook [5], the total generating capacity in Peninsular Malaysia is 24,105 MW. It is predicted that if the current global energy consumption pattern continues, the world energy consumption will increase by over 50% before 2030 [6]. Since the demand keeps increasing, thus a meticulous planning should be provided to enhance the power delivery to the consumer.

Efficient operation and planning of power systems become more important for a reliable and sustainable electricity supply [7]. Optimization is playing a vital and dominant role in the electric power system. Optimization problems in power system are diversified and can be categorized in terms of the objective function characteristics and type of constraints [8, 9]. Basically, system failure is caused by lack of